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Communication set in encoding information: An experimental investigation

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COMMUNICATION SET IN ENCODING INFORMATION:

AN EXPERIMENTAL INVESTIGATION

by

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TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

STATEMENT OF PROBLEM

Investigators of speech are interested in discovering factors which influence communication processes and in elucidating the significance of those factors so that men will better understand verbal behavior. When research in speech is under consideration, the particular method of approach is of fundamental importance.

In his article, "Speech as a Science," Simon claims that "Too few areas in speech at present profit from the application of the experimental method...too few opinions and beliefs in speech are subject to experimental testing."[1] Simon's comment suggests that experimental investigations of speech can contribute to our understanding of verbal behavior.

Auer defines experimental research in the following manner:

> ...experimental research is the systematic study of the operation and effect, or causal relationships, of a single variable factor (and occasionally of several variable factors), controlled or manipulated in a situation where all other essential factors are held constant.[2]

Although experimentation, like any method of research, has its limitations,[3] it offers certain advantages in assessing the behavioral

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[1] C. T. Simon, "Speech as a Science," The Quarterly Journal of Speech, 37:292, October, 1951.

[2] J. J. Auer, An Introduction to Research in Speech (New York: Harper & Brothers, 1959), p. 41.

[3] W. I. B. Beveridge, The Art of Scientific Investigation (New York: Random House, 1957), pp. 23-36.

effects of a particular speech variable; it enables the researcher to maintain control over those factors which may influence the phenomena under examination. In examining speech behavior, it is sometimes desirable to control the conditions under which the behavior occurs. For this reason, experimentation is sometimes considered a more appropriate research method than those which lack the same type of control characteristic. Such was considered the case in the present investigation; therefore, the experimental method was employed.

The Communication Process

Communication is often regarded as a process whereby individuals transfer information from one source or place to another.[4] In human societies this information frequently consists of arranged symbols that are transferable and refer to some particular thing or event. As information in the writer's investigation took the form of tape recorded verbalizations, information will here be considered in terms of its manifestations in spoken English.

Two operations fundamental to all communication systems are those of encoding and decoding. The encoding aspect of communication is here defined to include two functions reserved for the information transmitter: (1) selecting and arranging information pertinent to some specified nonverbal event and (2) verbalizing about that event. The primary concern of the encoder is to produce a message which will achieve his communication objective. Decoding designates that operation

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[4] G. A. Miller, Language and Communication (New York, Toronto, London: McGraw-Hill Co., Inc., 1951), p. 6.

in which the receiver engages in his attempt to determine the "meaning" of the message as it was intended by the encoder. Implied in this designation is the assumption that communication does not consist of the transmission and reception of "meanings." The same information does not necessarily "mean" the same thing to the encoder as it does to the receiver. Meanings, Berlo argues, "are in people," they "...are covert responses, contained within the human organism."[5] Because the meanings conveyed by verbal stimulation are such intangible entities, it is desirable to relate the stimulation to some observable response.

If encoding proficiency is to be evaluated scientifically, some objective criteria must be established. One such criterion, consistent with the point of view that assumes the primary purpose of communication to be one of influencing individual and group behavior,[6,7,8,9] is that identified by Weaver as "influence." According to Weaver, "The problems of influence...are concerned with the success with which the meaning conveyed to the receiver leads to the desired conduct on his part."[10]

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[5] D. K. Berlo, _The Process of Communication_ (New York: Holt, Rinehart and Winston, Inc.), p. 175.

[6] _Ibid._, pp. 11-12.

[7] G. W. Gray, and C. M. Wise, _The Bases of Speech_ (third edition; New York: Harper & Brothers, 1959), p. 4.

[8] Miller, _op. cit._, pp. 1 and 249.

[9] W. Weaver, "The Mathematics of Information," _Automatic Control_ (second printing; New York: Simon and Schuster, 1955), p. 98.

[10] _Ibid._, p. 98.

It is possible to limit an assessment of encoding proficiency to the factor of influence. Such a restriction does not intend to imply the absence of other factors in the operation of encoding; it simply constitutes an arbitrary decision to assess encoding as a function of influence. A study by Corman indicates that such an assessment is within the scope of experimental investigations of communication variables. Corman used influence as a single criterion for measuring the effects of varying amounts and kinds of information in problem solving.[11] His study indicated that "method information" was more influential than "rule information" in terms of helping subjects solve nine variations of Katona match stick problems.[12]

Because communication is often undertaken to influence an individual's behavior, writers like Berlo maintain that consideration of effective communication establishes the receiver as the "most important link in the communication process."[13]

> The receiver has to be kept in mind when the source (encoder) makes decisions with respect to each of the communication factors...[14]

Berlo's statement suggests that encoding effectiveness is enhanced when the encoder realizes he will be required to engage in communication.

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[11] B. Corman, "The Effects of Varying Amounts and Kinds of Information as Guidance in Problem Solving," Psychological Monograph, Vol. LXXI, No. 2, (Whole No. 431), 1957, pp. 1-18.

[12] Ibid., p. 18.

[13] Berlo, op. cit., p. 52.

[14] Ibid.

More specifically, it indicates that anticipation of communication enables an encoder to be more influential; it increases, that is, his capacity to control his listener's behavior. Such an expectancy to communicate will here be considered as constituting a set condition.

The Concept of Set

In his critical review of the concept of "set," James Gibson makes the following statement in order to emphasize the semantic confusion resulting from the multiple use of the term:

> The concept of set...is a nearly universal one in psychological thinking despite the fact that the underlying meaning is indefinite, the terminology chaotic, and the usage by psychologists highly individualistic.[15]

Gibson illustrates the validity of his assertion by listing over thirty words or phrases which are related to the concept of set as it appears in psychological writings. He concludes by asserting that "the term 'set' denotes a large and heterogeneous body of experimental facts and connotes rather different things to different psychologists."[16]

In experimental investigations of human behavior, set frequently refers to a specified stimulus which is assumed to influence the responses of the experimental subjects.[17] Often one group of subjects is "set" to react in a prescribed manner, while another is not.

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[15] J. I. Gibson, "A Critical Review of the Concept of Set in Contemporary Experimental Psychology," Psychological Bulletin, 38:781, 1941.

[16] Ibid.

[17] F. H. Allport, Theories of Perception and the Concept of Structure (New York: John Wiley & Sons, Inc.), pp. 212-213.

By comparing the behavior of the "set" and the "no set" group, the experimenter can measure the effects of set to some limited degree. If there are significant differences between the responses of the two groups, they are attributed to the influence of set, assuming, of course, that other variables which might affect the responses have been held constant in the experiment.

The factor of set has been investigated in a variety of situations. Most of these investigations support the assumption that set is a significant determinant of human behavior. Rees and Israel maintain that "Evidence from a variety of experimental fields seems to demonstrate rather conclusively that one of the most significant determinants of an individual's response to a situation is a factor which has been termed 'prepatory set,' 'attitude,' 'readiness,' 'determining tendency,' and 'mental set.'"[18]

Studies by Rees and Israel,[19] Hunter,[20] Gangé and Paradise,[21] and Katona[22] support the hypothesis that set is a significant determinant of a subject's responses during experimentation. Rees,

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[18] H. J. Rees, and H. E. Israel, "An Investigation of the Establishment and Operation of Mental Sets," Psychological Monograph, Vol. XLVI, (Whole No. 210), 1935, p. 1.

[19] Ibid., pp. 4-5.

[20] Ian M. L. Hunter, "The Influence of Mental Set on Problem Solving," British Journal of Psychology, Vol. XLVII, 1956, pp. 63-64.

[21] R. M. Gangé, and N. E. Paradise, "Abilities and Learning Sets in Knowledge Acquisition," Psychological Bulletin, (Whole No. 518) Vol. LXXV, 1961, p. 18.

[22] G. Katona, Organizing and Memorizing (New York: Morningside Heights, Columbia University Press, 1940), pp. 9-20.

Israel, and Hunter found that subjects set to solve anagrams in a specified manner recorded more solutions than subjects given no set. The Gangé and Paradise experiment indicated that knowledge relevant to mathematics facilitated achievement in solving simple linear equations. Katona's investigation, on the other hand, demonstrated that set can inhibit recall of a series of digits if it tends to "misdirect" the subject's initial learning of the series.

In the area of applied psychology, investigations of set have also been conducted. In one such experiment, Fattu and Mech examined set in relation to a "trouble shooting" situation. The investigators concluded that set facilitated locating defects in a gear-train apparatus.[23]

The results of such studies suggest that a profitable line of research would be an exploration of set in relation to some communication situation.

A Study of Set Pertinent to the Communication Process

Part of a study by Gangé and Smith was concerned with determining whether or not the ability to state verbally the "principle" underlying the solution to the Ewert-Lambert three circle problem was enhanced by the establishment of a "solution set."[24]

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[23] N. A. Fattu, and E. V. Mech, "The Effect of Set on Performance in a 'Trouble Shooting' Situation," Journal of Applied Psychology, Vol. XXXVII, No. 3, 1953, p. 216.

[24] R. M. Gangé and E. C. Smith, Jr., "A Study of the Effects of Verbalization on Problem Solving," Journal of Experimental Psychology, Vol. LXIII, No. 1, January, 1962, pp. 12-18.

The subjects of the experiment were divided equally among four groups, two being used to determine whether "instructions to search for a general principle which could be stated verbally after the tasks were solved"[25] would result in superior written explanations of the principle. Subjects of the "solution set" group (Group SS) were told to "try to formulate a rule" as they were solving the problem. The "no solution set" group (Group No) was simply instructed to solve the problem.

During the experiment subjects of both groups completed a number of variations of the three circle problem. The mean number of excess moves for each group was calculated to determine the degree of achievement, and the written statements of the principle were judged on the bases of "inadequate," "partial," and "complete."

Data gathered in the experiment suggested that Group SS (1) was more proficient in solving the three circle problem and (2) could state its principle with greater satisfaction than could Group No. The second conclusion suggests that the "solution set" enhanced the effectiveness of the communication inherent in the writing of explanations. However, at least two reasons exist for believing that the study does not confirm the conclusion. First, as the comparison of mean excess moves demonstrated that Group SS was superior to Group No in performance, it is possible that a more adequate understanding of the problem's solution was responsible for the more adequate statements of the principle, not the "solution set" per se. Second,

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[25]<u>Ibid</u>., p. 13.

the adequacy of the explanations was based on human judgment; therefore, it would be rather dubious to conclude that "partial" statements constitute more effective communication than "inadequate" statements or less effective communication than "complete" statements in terms of informing others how to solve the problem. These two reasons suggest the desirability of gathering more experimental evidence which would indicate the relationship between set and communication effectiveness.

Statement of the Problem

The present investigation, like that of Gangé and Smith, was designed to determine the effect of "set" in the process of explaining a nonverbal event. The two investigations parallel one another in that both compared the communication proficiency of a "set" and a "no set" group. However, the present investigation differs in the following respects: (1) a different nonverbal event was the object of communication; (2) subjects' explanations were recorded verbalizations, not written explanations; (3) subjects required to explain the experimental task had all achieved its mastery; and (4) adequacy of the explanations was determined on the basis of responses made by receiver subjects who performed the experimental task after listening to one of the recorded explanations of the task.

"Communication set," as defined for the investigation, refers to instructional information which warns a subject that he will have to record an explanation of the experimental task. Five three-line displays on a Vocom (vocal communication) apparatus constituted the nonverbal events about which encoder subjects communicated.

The problem was to determine the effect of communication set on the process of recording an explanation of the displays. It was hypothesized that "set" encoders would record more satisfactory explanations than "no set" encoders. The ultimate criterion for judging the explanations was based on the responses made by receiver subjects who completed the displays after listening to either an "encoder set" or an "encoder no set" recording.

A secondary purpose of the investigation was to examine the application of the Vocom apparatus in communication experimentation.

CHAPTER II

PROCEDURE

The procedure of this experiment made possible a comparative measure of the performance of two receiver groups. This performance was assumed to be a function of communication under a "set" and a "no set" condition. In addition, the investigation furnished data for evaluating the usefulness of the Vocom apparatus in experimental research.

<u>The Apparatus</u>*

The two by four foot Vocom apparatus used in the experiment consists of an eighteen and one-quarter inch square control panel and a <u>board</u> of identical size through which are drilled 256 holes one-quarter inch in diameter and spcaed one and one-quarter inches apart and arranged in a square matrix of sixteen holes to a side. Mounted in each board is a phone-jack. Vertical and horizontal rows containing sixteen holes each indicate the semblance of the board.

Beneath the board is a sliding drawer through the bottom of which are drilled 256 holes that align with the board holes when the drawer is closed. Between the board and the drawer is a one-eighth inch sheet of masonite through which are also drilled 256 holes in

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*The Vocom apparatus was designed by F. L. Brissey, Associate Professor of Speech, Montana State University for the purpose of investigating communication variables in an experimental setting. The preliminary research, of which the present investigation is part, was conducted under a research grant sponsored by the Air Force Office of Scientific Research and Development Command.

accordance with the board holes. Fastened to the bottom of the drawer is a one-sixteenth inch sheet of durable cardboard through which is cut a selected pattern. This cardboard sheet is referred to as the <u>template</u>. The template enables the experimenter to "block" certain holes during experimentation.

The control panel houses 256 manually-operated switches that engage electrical contact with the corresponding phone-jacks of the board. Contact resulting from closed switches is broken when a subject inserts round dowels one-quarter inch in diameter and three and one-half inches long---referred to as pegs---through the appropriate holes.

During experimentation a <u>score sheet</u> is placed between the board and the masonite sheet for the purpose of recording a subject's correct and incorrect peg placements. The subject's task is to open all electrical contacts by inserting pegs in those holes which constitute the board <u>display</u>. Each peg inserted in the board holes punctures the score sheet. When all display holes have been filled with pegs, a buzzer is automatically sounded, signaling the subject to stop.

Subjects can complete the task under two apparatus conditions. One of these conditions is designated <u>feedback present</u>; the other <u>feedback absent</u>. Operationally defined, feedback present refers to the presence of the template during experimentation; feedback absent indicates its removal. Subjects engaged in the task under the feedback present condition know which of their peg placements are correct and which are incorrect, as pegs placed in nondisplay holes will be blocked by the template and remain extended approximately two inches above the board, whereas pegs placed in display holes will continue on through the cut-out section of the template and remain extended by only one inch. Therefore, feedback present subjects have visual access to the board display and their decision errors by observing the arrangement of depressed and elevated pegs. To the feedback absent subject, this observation is unavailable as all pegs are equally depressed. Thus, if a feedback absent subject is to predict the locations of display holes, he must be informed in some other manner.

The Displays

In order to avoid bias in the process of selecting peg patterns which would serve as events for communication, randomization was employed in generating five three-line displays.

For scoring purposes it was desirable that all displays contain an equal number of pegs. Also, it was felt that each display should present an equally difficult communicative task. Therefore, it was arbitrarily decided that each display should consist of one vertical, one horizontal, and one diagonal line, each of which extended from one border of the board to the other. To facilitate verbal descriptions of the displays, each of the lines contained one white "landmark" peg. Further, the diagonals were to contain thirteen pegs. These rules provided for the selection of a number of possible combinations of vertical, horizontal, and diagonal lines.

The three lines of each display were determined by using a table of random numbers. The locations of the white "landmark" pegs were determined in the same manner. The displays resulting from following this procedure appear in Appendix A, pages 51-55.

The Subjects

The subjects of the experiment were all male undergraduate students enrolled at Montana State University during Winter and Spring Quarters, 1963. They were randomly assigned to four groups of twenty-five subjects each: two encoder groups (ES and ENS) and two receiver groups (Rs and Rn). ES subjects constituted the "encoder set" group, and Rs subjects were their receivers. ENS was the "encoder no set" group, and Rn subjects were their receivers.

Procedure

To obtain a reliable measurement of the effect of communication set in the process of encoding information relevant to three-line Vocom displays, it was necessary to exercise maximum control over the following factors: (1) subjects of Group ES should know that they would have to record a description of their display sometime prior to the recording session, and subjects of Group ENS should have no such communication expectancy, (2) the two encoder groups should be approximately equal in communication ability, (3) the ability of the two receiver groups to understand the encoders' messages and to apply the information therein to completing the displays should be similar, and (4) subjects should possess no information pertaining to their particular display prior to experimentation.

Controlling the first factor involved (1) running ENS subjects first so as to minimize the possibility of their being informed by other subjects concerning the communication requirement of the experiment, (2) removing all clues from the testing environment which might indicate to ENS subjects that communication was an experimental factor, (3) telling ENS subjects that the experiment was primarily concerned with "factors related to two-dimensional visual problems, and (4) telling ES subjects and not telling ENS subjects that a recorded explanation would be required of them once they had mastered the display. The second and third conditions were assumed to be controlled through random assignment of subjects to all four groups. And the fourth factor was controlled in two ways: (1) by requesting all subjects to refrain from talking to anyone about their experience, and (2) by using a number of three-line displays rather than a single one in the experiment.

Treatments of the four groups were as follows:

Group ES. Group ES (encoder set) was composed of twenty-five subjects who were approached in the following manner by the experimenter upon their arrival at the experimental room:

> Have you been up here before? Perhaps you already know something about the work we have been doing. Our equipment is used for many purposes. What we want to do today is somewhat different than what we have done in the past.
>
> Right now we are interested in factors related to two-dimensional visual problems. If you will take the seat in front of the apparatus, I will tell you more about our particular problem.

After ES subjects were seated in front of the board which contained the three white landmark pegs of each line, they were instructed as follows:

> Some of the holes on this board go all the way through and others are blocked. Your task is to discover the complete arrangement of open holes and to fill these holes with pegs. If a peg drops well

into the hole you will know that the hole is open and your decision was correct. If the peg stands up in the hole, you have made an error. It is important for you to make as few errors as possible.

Notice the white pegs. Push each one down just firmly enough to seat in the board. They also seat well into the hole which indicates that the hole is open.

Once you have placed a peg in a hole you must leave it and select a new peg for the next hole you decide to test. You may start anywhere you choose, and there is no time limit. When you have finished the correct arrangement, this buzzer will sound (experimenter demonstrates by sounding the buzzer) so keep working as long as the buzzer is off.

Your task, remember, is to discover the complete arrangement of open holes and to fill these holes with pegs. It is important for you to make as few errors as possible; that is, to end up with as few standing pegs as possible. After you have completed an error-free trial, you will record a message in which you explain the correct peg arrangement to another individual. Keep this requirement in mind as you work.

Once you have started to work I will not be able to answer any questions, so if you have any please ask them now.

Between each trial the experimenter removed the pegs from the board and read the following instructions:

Now you know what the correct arrangement looks like. Before you begin your next trial, I would like to remind you that it is important for you to make as few errors as possible. Also, remember that you will be required to record an explanation of the peg arrangement once you have completed an error-free trial.

When a subject had reproduced the peg arrangement without making an error, he was seated before a Magnecorder, Type PT6-J and read the following instructions:

You have now learned to make the correct arrangement. Now I want you to tell another person exactly how to complete the same task. In other words tell the

> other person exactly what the arrangement looks like so that he can place the pegs without making any errors. The person who listens to your message will know the general nature of the task, and he will see the board just as it was when you first saw it.
>
> Once you begin the recording, I will not be able to answer any questions, so if you have any please ask them now.
>
> You may talk as long as you wish. When you have finished, signal me by raising your hand and I will turn the recorder off.

After the subject had finished his recording, he filled out a data sheet like that shown in Appendix B, page 57. When he had done this, the experimenter requested the subject to refrain from talking to anyone about his experience as a subject. The subject was then dismissed.

Group ENS. Group ENS (encoder no set) was composed of twenty-five subjects who listened to the same instructions as Group ES, with the exception of the fifth paragraph of the "task" instructions and the inter-trial instructions. The fifth paragraph of the ENS instructions was the following:

> As I previously indicated, we are presently interested in certain aspects of two-dimensional problem solving. We believe that a student's performance on this task will give us the information we want.

The between-trial instructions for Group ENS were the following:

> Now you know what the correct arrangement looks like. Before you begin your next trial, I would like to remind you to make as few errors as possible.

When a subject of Group ENS had completed an error-free trial, he was seated in front of the recorder which had been concealed from view and instructed in the same manner as ES subjects.

After the subject finished his recording, he filled out the data sheet and was requested by the experimenter to refrain from talking to anyone about his experience as a subject. The individual was thanked for his cooperation and dismissed.

Group Rs. Subjects of this group were randomly assigned to recordings taped by ES subjects. When they arrived for experimental participation, they were seated before the recorder and instructed as follows:

> I want you to listen to a recording. The recording will explain a task which you will later be required to complete, so listen very carefully to the explanation.

The subject listened to the appropriate recording and was then seated in front of the Vocom board and instructed in the following manner.

> You have just listened to a recording which attempted to acquaint you with a display that can be arranged on the board in front of you by inserting pegs in the appropriate holes. Your task is to insert pegs in those holes which you believe to be a part of the arrangement just explained to you by the recording. When you have finished the task this buzzer (experimenter demonstrates buzzer sound) will sound; so keep working as long as the buzzer is off. It is important for you to make as few errors as possible.
>
> Once you have placed a peg in a hole you must leave it and select a new peg for the next hole you decide to test. You may start anywhere you choose and there is no time limit.
>
> Once you have started to work I will not be able to answer any questions, so if you have any please ask then now.
>
> You may begin.

Group Rn. Subjects of Group Rn were randomly assigned to recordings taped by ENS subjects. These receivers were then treated in the identical manner as those of Group Rs.

CHAPTER III

RESULTS

As stated in the preceding chapter, subjects were randomly assigned to the two encoder and two receiver groups. Likewise, all receivers were randomly assigned to encoder recordings. Because the experiment was conducted during two quarters, a number of subjects scheduled for the latter quarter were unavailable at the time they were to be run. The majority of these subjects were forestry students attending an out-of-town spring camp, others had dropped out of school or taken part-time jobs, and a few more were unable to participate for other reasons. Therefore, other students had to be substituted in their place. A total of thirty-two substitutions was made.

All data have been treated so that encoders and receivers are considered as teams. For example, ES-12 would identify a particular "set" encoder, and Rs-12 would be his receiver.

The performance of subjects was assessed by ascertaining the number of pegs which they had placed in nondisplay holes. This assessment was accomplished through an examination of the score sheets. The punctures that constituted errors were counted, and the total number of such punctures yielded the subjects' error scores. The higher the error score the poorer the performance. After each score had been recorded, the subjects were ranked accordingly. The lowest rank numbers were assigned to the subjects with the lowest error scores, and the highest to those with the highest scores. All data pertaining to error scores have been treated so that the low ranking numbers designate the superior performers.

The error scores of receiver subjects were the performance measurements used in testing the research hypothesis. This hypothesis predicted that the error scores of Group Rs would be lower than those of Group Rn. If a statistically significant difference was revealed, it would be interpreted as indicating that communication under the condition of set was responsible for the error score variation between the two receiver groups.

Receiver performance, as manifested numerically in error scores, probably represents no more than ordinal scaling. For this reason the nonparametric Mann-Whitney U Test was considered an appropriate statistic.[26,27] Because the hypothesis predicted the direction of error score difference, a one-tailed test was used. Also, as this was the first investigation of set employing the Vocom apparatus and as the set established was believed to be relatively mild, there seemed to be reason for avoiding a Type II error. No serious theoretical or practical consequences seemed imminent in the event a Type I error was committed; therefore, the level of significance was set at ten per cent.[28]

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[26] S. Siegel, Nonparametric Statistics for the Behavioral Sciences, (New York, Toronto, London: McGraw-Hill Book Co., Inc., 1956), pp. 95-96 and 116.

[27] N. M. Downie and R. W. Heath, Basic Statistical Methods (New York: Harper and Brothers, 1956), p. 212.

[28] J. P. Guilford, Fundamental Statistics in Psychology and Education (third edition; New York, Toronto, London: McGraw-Hill Book Co., Inc., 1956), pp. 215-217.

The Influence of Set

In the experiment the scores of twenty-one receiver subjects involved ties. Seventeen subjects received scores of zero, two of 156, and two others scores of 211. For this reason a correction for ties was calculated. A "z" value of 1.28 is required for significance at the ten per cent level of confidence for a one-tailed test. As the corrected "z" value, yielded by the analysis which contained the scores of all receivers, was only 1.20, there at first seemed to be reason for not rejecting the null hypothesis. However, five of the ENS subjects had participated in previous Vocom experiments, two as "encoders" and three as receivers. Also, four ES's had previous experience as subjects, none, however, as encoders. A comment by one of the previously-tested ENS subjects made it evident that he had expected to record an explanation, and it is probably that the other four ENS subjects had a similar anticipation. For this reason a second Mann-Whitney test was calculated, excluding the data of the receivers who listened to messages of these previously-tested ENS subjects. This test yielded a corrected "z" of 1.54, which is significant at the specified confidence level.

Encoder data showed that fewer ES than ENS subjects required more than a second trial to master the three-line displays. A Chi Square was computed to determine if this difference was significant. As Table I indicates, the Chi Square value obtained is significant at the ten per cent level of confidence. Also, it was observed that for the first trial the median error score for Group ES was lower than that of ENS. For this reason subjects of both encoder groups were ranked according to error scores, and the Mann-Whitney test was applied.

TABLE I

SUMMARY OF CHI SQUARE TEST OF DIFFERENCE BETWEEN THE NUMBER OF ENCODERS REQUIRING MORE THAN TWO TRIALS TO MASTER THE LINE DISPLAYS

Group	Mastery on Trial 2	Mastery After Trial 2	Chi Square Value
ENS	14	11	4.506*
ES	20	5	

*Indicates significance at the ten per cent level. A value of Chi Square equal to 2.11 is required for significance at the ten per cent level, with one degree of freedom.

Because twenty-one scores involved ties, the correction formula was again employed. The 0.84 "z" value was not significant at the ten per cent level, nor was the 0.94 "z" value obtained after the elimination of the five previously run encoders significant.

The Displays

In Chapter II the assumption was made that all five three-line displays would constitute equally difficult communicative tasks. In order to test this assumption statistically, error scores of all receivers were ranked according to display number. After these ranks had been totaled, the Kurskal-Wallis One-Way Analysis of Variance was computed to test the assumption's validity. A correction for ties was again computed. A value of "H" equal to 9.49 with four degrees of freedom is required for significance at the ten per cent level for a two-tailed test. The "H" value obtained was only 3.50; therefore, the initial assumption appears to be acceptable.

Feedback and Messages: A Comparison

With the presence of feedback for all encoders and its absence for all receivers, it was possible to compare the effect of feedback on encoder error scores with that of recorded explanations on receiver error scores. To perform this comparison, it was necessary to rank subjects of Group ENS with those of Rn, and ES subjects with Rs subjects. This was accomplished by ranking first trial error scores of encoders with the error scores of their respective receivers. After this had been done, two Mann-Whitney tests were calculated to determine if the error score difference between Group ENS and Rn was statistically significant; one test included the error scores of the previously run encoders and their receivers and one eliminated them. As the direction of error score differences between encoders and receivers was not predicted, a two-tailed test was used. A "z" of 1.65 is required for significance at the ten per cent level for a two-tailed test. Both "z" values for the comparisons between ENS and Rn were significant; the first at 1.92 and the second at 1.91. The "z" value for the other two groups was a nonsignificant 0.37.

The Time Factor

Trial times for all subjects were kept, and mean times were derived from them for each of the four groups. Also, mean recording times for the two encoder groups were computed. t-tests were calculated to determine if significant differences existed between any of these means.

The mean times for task completion for the two receiver groups were approximately the same. Group Rn had a mean time of 15.85 minutes, and Group Rs had one of 15.05 minutes. As Table II shows, this difference is not significant. Nor were differences significant between encoder groups for either Trial One or for the total amount of time required to achieve a zero error score. These two mean time comparisons are summarized in Tables III and IV, respectively. There was a significant difference, however, between the encoders' first trial times and the receivers' trial times. Encoders took less time to complete the displays on their first trial than did receivers on their trial.

TABLE II

MEAN TIMES IN MINUTES FOR THE TWO RECEIVER GROUPS

Group Rn	Group Rs	"t" Value
15.75	15.05	0.116

A value of "t" = 1.671 is required for significance at the ten per cent level for a two-tailed test.

TABLE III

FIRST TRIAL MEAN TIMES IN MINUTES FOR GROUPS ENS AND ES

Group ENS	Group ES	"t" Value
9.29	7.98	0.459

A value of "t" = 1.671 is required for significance at the ten per cent level for a two-tailed test.

TABLE IV

CUMULATIVE TRIAL MEAN TIMES IN MINUTES FOR GROUPS ENS AND ES

Group ENS	Group ES	"t" Value
12.18	10.73	0.636

A value of "t" = 1.671 is required for significance at the ten per cent level of confidence for a two-tailed test.

Table V presents the data of this analysis. Also, "mastery" trial time differences between ENS and ES were significant. This test of significance is summarized in Table VI.

Mean recording times for the two encoder groups were almost identical. Group ENS had a mean recording time of 1.67 minutes and Group ES had one of 1.53. As Table VII illustrates, this difference is not significant.

TABLE V

MEAN TIMES IN MINUTES FOR ENCODERS' FIRST TRIAL
AND RECEIVERS' SINGLE TRIAL

Encoders	Receivers	"t" Value
8.64	15.40	2.94*

*Indicates significance at the ten per cent level. A value of "t" = 1.645 is required for significance at the ten per cent level for a two-tailed test.

TABLE VI

MEAN MASTERY TRIAL TIMES IN MINUTES FOR GROUPS ENS AND ES

Group ENS	Group ES	"t" Value
1.59	2.25	2.067*

*Indicates significance at the ten per cent level. A value of "t" = 1.671 is required for significance at the ten per cent level for a two-tailed test.

TABLE VII

MEAN RECORDING TIMES IN MINUTES

Group ENS	Group ES	"t" Value
1.57	1.53	0.173

A value of "t" = 1.671 is required for significance at the ten per cent level for a two-tailed test.

CHAPTER IV

DISCUSSION

The essence of this investigation was such that it necessitated limiting the possibility of subjects obtaining accurate knowledge of their particular display prior to experimental participation. As the experiment was conducted over a period of approximately two months, there was danger that inquisitive subjects who had not yet been run might request and obtain display information from subjects who had already participated in the experiment. To reduce this danger, five displays were used instead of one. In the event that subjects disregarded the experimenter's request to refrain from discussing their experience, the use of five displays decreased the probability of their talking with someone who would later be exposed to the same display.

While the safeguard of using five different displays was desirable, it was necessary, at the same time, to present all encoders with equally difficult communicative tasks. The resort to line displays having an equal number of pegs that were arranged in similar patterns seems to have accomplished this objective. As the Kruskal-Wallis One-Way Analysis of Variance (Chapter III, p. 24) indicates, the difference in receiver error scores, ranked according to display numbers, are no greater than would be expected to occur by chance. For this reason it seems safe to conclude that the five displays used in the experiment constituted equally difficult communicative tasks. What cannot be ascertained from the data available, however, is whether one type of line presented encoders with a greater communicative burden than another type.

The experimenter noticed that receivers tended to complete the horizontal and vertical lines more readily than they did the diagonals. It was frequently observed that receivers took little time in filling the vertical and horizontal lines with pegs and also made very few mistakes in the process. After these two lines were completed, the subject would frequently slow his pace and make many more errors. A possible explanation of this phenomenon will be suggested when the contents of the recorded messages are discussed later in this chapter.

The E-Signal

The Vocom apparatus is wired so that subjects may either signal the experimenter when they feel they have completed the display, or they can be forced to continue placing pegs in the board until all display holes have been filled. The former signaling procedure is referred to as the S-signal condition, and the latter as the E-signal condition. Obviously, this experiment employed the latter.

With the absence of feedback, the E-signal appears to have one definite limitation; it tends, in some instances, to prevent a meaningful interpretation of error scores. In some cases, for example, receivers would complete two of the display's lines before making a single error, indicating that encoders had adequately explained that particular portion of the display. In their attempt to locate the remaining line, these receivers would sometimes inflate their error scores considerably. Some error scores in such cases were over two hundred. One Rs subject, for example, had but three pegs missing from his display prior to committing a single error. However, he had made 211 errors by the time he completed the display. It would seem that this subject's error score, especially, is not a valid indication of the display knowledge he possessed.

The extent of this "type" of performance is unknown, but it should be kept in mind whenever receiver error scores are under consideration. A fruitful line of research would be a similar exploration of communication set which substituted the S-signal for the E-signal condition. Such an experiment might provide for a more reliable measurement of communication effectiveness under the condition of set.

Receiver Performance

The relationship between communication effectiveness and set as established in this experiment was examined by comparing the error scores of the two receiver groups. The obvious assumption of such an examination is that receiver performance is primarily a function of the encoders' recordings. A reliable measurement, then, of communication effectiveness in this study dictated a fundamental concern for avoiding communication expectancy with reference to Group ENS. It is quite possible that this variable was not controlled due to the fact that five ENS subjects had previously participated in Vocom experiments. If the data of the receivers of these encoders are valid, then the null hypothesis cannot be rejected (Chapter III, p. 22). However, when the data of these receivers are eliminated from the analysis, the error score difference between the two receiver groups is significant at the specified confidence level (Chapter III, p. 22). As the argument favoring rejection of the "contaminated" data seems stronger than the one for accepting it, it seems safe to conclude that communication is more effective under a "set" than a "no set" condition. The "contamination" does, however, suggest that a profitable line of research might be a replication of the present experiment with the exception that all subjects be drawn from a naive population.

Although receiver error scores would seem essentially a function of recorded messages, the "decoding proficiency" of receiver subjects should not be overlooked. As neither of these two factors can be operationally defined in this study, any discussion of them is highly speculative. Nevertheless, a few qualified comments pertaining to the interaction of the two variables seems legitimate.

The experimenter listened quite carefully to all recordings a number of times and also scrutinized their written transcriptions. On the bases of these subjective observations, it would appear that some receivers were more adept than others in compensating for "limitations" inherent in certain messages. For example, ENS-12's explanation of the vertical line of display number five is in error, and his description of the diagonal somewhat "vague" (See Appendix H, p. 78). After placing pegs in the wrong vertical row, Rn-12 apparently recalled the recording stating that all lines went through white "plungers." He went on to complete the peg pattern without making any more errors; the "vague" description of the diagonal apparently causing him no trouble. On the other hand, ENS-23's message (See Appendix H, p. 78) was judged by the experimenter as being more adequate than the one of

ENS-12. However, Rn-23 made 211 errors, while Rn-12 made but fifteen. Many similar incidents could be mentioned, but because of the highly speculative nature of such a discussion, these references would appear to contribute little concrete evidence. A study which would provide statistical correlation between human judgments of message adequacy and receiver error scores is suggested by the data. Such a study would also determine whether there is much variation in error scores among receivers listening to the same messages.

Encoder Performance

As mentioned in Chapter I, the results of the Gangé-Smith study indicated that a "solution set" facilitated subject performance in solving variations of the Ewert-Lambert three-circle problem. The implication is that warning a subject of the "communication" requirement not only resulted in superior written explanations, but also in reducing the number of moves required to rearrange the discs properly. The present investigation revealed a similar phenomenon.

Subjects of Group ES required fewer trials than those of Group ENS to reproduce three-line displays without error. This result, then, is consistent with the findings of Gangé and Smith and indicates that performance on the experimental task was facilitated by the treatment of the "set" group. Also, the encoder first trial error scores tend to reveal the same influence. Although the difference was not of statistical significance, ES subjects were inclined to make fewer errors than ENS subjects during the first trial.

Although subjects of Group ES were instructed that a recorded explanation of the correct peg arrangement was a part of the experiment, the extent of their communication "preparedness" cannot be determined objectively. Nevertheless, there is reason to question the presence of a variable within this group that simulated a set condition which involved the "readiness" of subjects to execute the task for which they had been set. The experimental procedure was such that it forced all encoders to record their messages immediately following their mastery trial. When the buzzer sounded, the correct peg arrangement was covered by closing the apparatus lid over the matrix. It is estimated that at least one-third of the ES subjects requested additional time to study their displays before having to make their recordings. The request was denied to prevent the possibility of biasing the results in favor of the research hypothesis. The only possible way a subject could obtain additional time to study his display was through a self-imposed delay during his trials.

It is difficult to establish a meaningful relationship between time and the extent of communication preparedness in this experiment, but the variable of time appears to be extremely important. The mastery trial times may have been especially crucial, for it was immediately following this trial that encoders recorded their messages. As Table VI on page 31 indicates, ES subjects took 0.65 minutes more, on the average, to complete their mastery trial. This time difference, though less than a minute, is statistically significant and undoubtedly had some influence on the adequacy of the messages recorded by ES subjects. The mastery trial times of two ES subjects tend to further support this hypothesized relationship between message adequacy and mastery trial times. ES-12 took 8.03 minutes to complete his mastery trial and ES-22 took 5.57 minutes. These were the longest mastery trial times of all encoders. ES-12 and ES-22 were, in the experimenter's judgment, the only two encoders who purposely prolonged their mastery trial; they both withheld the last few pegs in order to study the peg arrangement. This willful delay undoubtedly enabled these two encoders to "set themselves" for the communication task; and there is reason to believe that it increased the effectiveness of their messages, for the receivers who listened to these two recordings both made zero error scores. Because of the implications of these time factors, a profitable line of research might be one which allowed a set group to study the displays for a specified length of time after the mastery trial.

With regard to encoder times, it should be mentioned that although ES subjects took more time on their mastery trial, they took less time to achieve mastery (See Table IV, p. 28). Group ENS took 1.45 minutes longer, on the average, to master the displays than did Group ES. This insignificant time difference is unquestionaly attributable, in part at least, to the fact that ENS subjects made more errors and required more trials to reach mastery than the former group. What effect the total time taken by encoders had on their messages is uncertain. With the exception of ES-12 and ES-22, the effect was probably negligible, however.

The Messages

Although some sort of linguistic analysis of encoders' recorded verbalizations would be unmanageable, the discussion would be incomplete without reference to certain predominant message characteristics.

As mentioned in Chapter II, the white "landmark" pegs were put in the displays for the expressed purpose of facilitating verbal description of the five peg arrangements. In the preliminary Vocom experiments, when such communication aids were not provided, subjects tended to engage in a process of hole counting in describing the displays. Such messages tended, apparently, to tax the digital memory span of receivers, for their error scores were generally extremely high. For this reason the incorporation of landmarks was introduced into the displays.

In this investigation the majority of encoders made reference to the white pegs. Of the twelve who did not, eleven engaged in a "hole-counting" procedure in their attempts to explain the peg arrangements. However, as hole counting was not restricted to subjects who made no reference to white pegs, messages could not be categorized on a hole-counting basis. Therefore, a statistical analysis of error score differences between receivers who listened to different "types" of messages does not seem scientifically permissable. It should be mentioned though that of the eleven receivers who listened to messages which made no references to white pegs only eighteen per cent made zero error scores, whereas forty per cent of those who listened to the remaining messages had perfect performance. Empirical confirmation or negation of the facilitating effect of "landmarks" on communication would involve an experiment in which the displays of one encoder group contained the white pegs and the same displays of a second encoder group did not.

As indicated earlier in this chapter, receivers seemed usually to complete the horizontal and vertical lines more easily than they did the diagonals and with fewer errors. An examination of the transcribed recordings seems to indicate that diagonals are more resistant to "adequate" description than are horizontals and verticals. The concepts of left and right in the description of displays were frequently used to reinforce explanations of horizontal lines and the concepts of top and bottom to reinforce those of the vertical lines (See Appendix H, Messages of ENS-2 and ES-5, on page 79). As the data collected have no way of revealing this hypothesized difference between the communication difficulty of thetypes of lines, the suggestion that diagonals presented a more difficult communicative task is highly speculative. Further research is needed before any such tentative conclusion can be reached objectively.

Comparisons between the displays and other objects were noted in many messages. The most common was the comparison of display five with an upsidedown figure four (See Appendices A, p. 55 and H, Messages of ENS-23 and ES-16, pp. 78, 80). The statistical test of significance between receiver error scores ranked according to displays (See Chapter III, p. 24) would indicate that this particular analogy did not effect better communication.

Perhaps the most noteworthy findings of this investigation are those which suggest the profitable application of the Vocom apparatus in the examination of communication related variables. Also, considering the implications of encoder performance, it would appear that Brissey's apparatus would be especially applicable to research in the area of human problem solving. Further, correlational studies between I. Q. scores and error scores of feedback present subjects would seem especially profitable.

CHAPTER V

SUMMARY AND CONCLUSIONS

The primary objectives of this investigation were to (1) examine communication effectiveness in relation to the concept of set and (2) to study the general procedure employed in Vocom experimentation.

One hundred undergraduate students enrolled at Montana State University were randomly assigned to four groups, two encoder groups (ENS and ES) and two receiver groups (Rn and Rs). Group ES constituted the "encoder set" group and ENS the "encoder no set" group. Group Rs and Rn were their respective receivers.

Five peg patterns, each consisting of one vertical, one horizontal, and one diagonal line, arranged on a Vocom apparatus provided events for communication for the two encoder groups. An encoder's first task was to complete one of the peg arrangements without error. A condition of "feedback" was provided to facilitate his learning the pattern. This condition allowed the encoder visual access to both his correct and incorrect peg placements after each trial. After encoders had completed their error-free trial, they recorded messages in which they attempted to describe the peg pattern so that an individual listening could complete the arrangement without error. Preliminary and intertrial instructions were so worded that ES subjects were informed of the communication requirement, while ENS subjects were not. Rn subjects then listened to ENS messages, and Rs subjects to ES messages. After listening to his message, the receiver was instructed to produce the peg pattern described, making as few errors as possible.

To determine whether communication under a condition of "set" was more effective than under a "no set" situation, error scores of receivers were evaluated for statistical significance. In addition, error scores of encoders were compared to see if set facilitated encoder performance. Encoder scores were also compared with those of receivers to detect possible differences between the effects of messages and feedback. Further, a number of mean time comparisons were made to determine possible influences of set and feedback among the four groups.

Analyses of the data tended to support the following conclusions:

(1) A condition of set increases communication effectiveness when the data of five receivers who listened to recordings of previously tested ENS subjects are eliminated.

(2) Communication set facilitates encoder performance in learning three-line Vocom displays.

(3) Performance of "set" encoders tends to approximate that of their receivers, but performance of "no set" encoders is superior to that of their receivers.

(4) Although set does not affect time required by encoders to complete their first trial or to reach mastery, it does prolong the mastery trial itself.

(5) Receivers of "set" and "no set" messages take approximately the same amount of time to complete three-line displays.

(6) The tendency of "feedback" alone is to reduce the time

required to complete three-line displays as compared to the time required to complete them by the guidance of message alone.

(7) Set does not influence the amount of time taken by encoders to record their explanations of three-line displays.

(8) The Vocom apparatus appears to have promise as an instrument for assessing communication related variables.

BIBLIOGRAPHY

BIBLIOGRAPHY

A. BOOKS

Allport, F. H. Theories of Perception and the Concept of Structure. New York: John Wiley & Sons, Inc.

Auer, J. J. An Introduction to Research in Speech. New York: Harper & Brothers, 1959.

Berlo, David K. The Process of Communication. New York: Holt, Rinehart and Winston, 1960.

Beveridge, W. I. B. The Art of Scientific Investigation. New York: Random House (Modern Library Paperbacks), 1957.

Downie, N. M. and R. W. Heath. Basic Statistical Methods. New York: Harper & Brothers, 1956.

Gray, B. W., and C. M. Wise. The Bases of Speech. Third edition. New York: Harper & Brothers, 1959.

Guilford, J. P. Fundamental Statistics in Psychology and Education.

Katona, G. Organizing and Memorizing. New York: Morningside Heights, Columbia University Press, 1940.

Miller, G. A. Language and Communication. New York, Toronto, and London: McGraw-Hill Book Co., 1951.

Siegel, S. Nonparametric Statistics for the Behavioral Sciences. New York, Toronto, and London: McGraw-Hill Book Co., 1956.

B. PERIODICALS

Corman, B. "The Effects of Varying Amounts and Kinds of Information as Guidance in Problem Solving," Psychological Monograph, LXXI (1957).

Fattu, N. A., and E. V. Mech. "The Effect of Set on Performance in a 'trouble shooting' Situation," Journal of Applied Psychology, XXXVII (1953).

Gangé, R. M., and N. E. Paradise. "Abilities and Learning Sets in Knowledge Acquisition," Psychological Bulletin, LXXV (1961).

Gangé, R. M., and E. C. Smith, Jr. "The Effects of Verbalization on Problem Solving," Journal of Experimental Psychology, LXIII (1962).

Gibson, J. I. "A Critical Review of the Concept of Set in Contemporary Experimental Psychology," Psychological Bulletin, XXXVIII (1941).

Hunter, Ian M. L. "The Influence of Mental Set on Problem Solving," British Journal of Psychology, XLVII (1965).

Rees, H. J. and H. E. Israel. "An Investigation of the Establishment and Operation of Mental Sets," Psychological Monograph, XLVI (1935).

Simon, C. T. "Speech as a Science," The Quarterly Journal of Speech, XXXVII (1951).

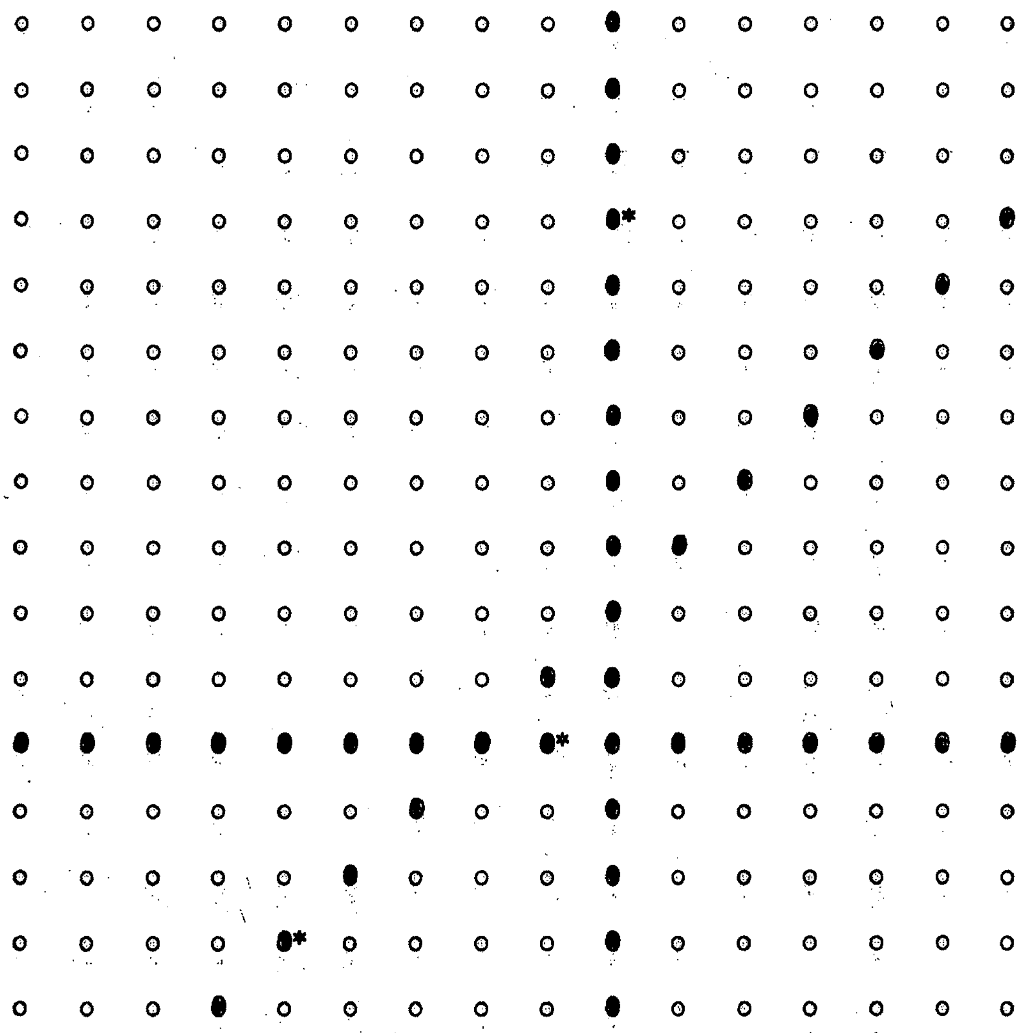
Weaver, W. "The Mathematics of Information," Automatic Control. New York: Simon and Schuster, 1955.

APPENDICES

APPENDIX A

THE DISPLAYS

DISPLAY NUMBER ONE



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o Indicates nondisplay holes.

● Indicates display holes.

●* Indicates white "landmark" pegs.

DISPLAY NUMBER TWO

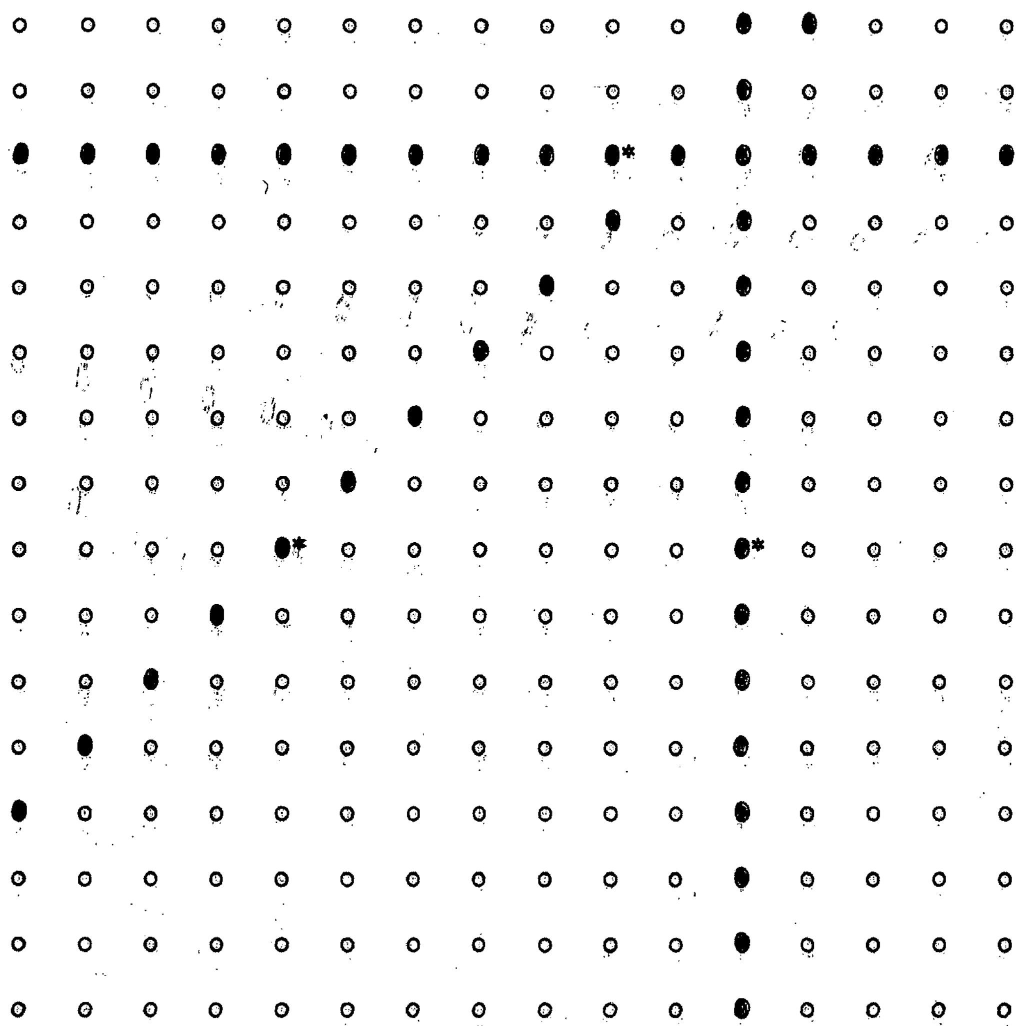
o	o	o	●	o	o	o	o	o	o	●	o	o	o	o	o
o	o	o	o	●	o	o	o	o	o	●	o	o	o	o	o
●	●	●	●	●	●	●	●	●	●*	●	●	●	●	●	●
o	o	o	o	o	o	●	o	o	o	●	o	o	o	o	o
o	o	o	o	o	o	o	●	o	o	●	o	o	o	o	o
o	o	o	o	o	o	o	o	●	o	●	o	o	o	o	o
o	o	o	o	o	o	o	o	o	●	●	o	o	o	o	o
o	o	o	o	o	o	o	o	o	o	●	o	o	o	o	o
o	o	o	o	o	o	o	o	o	o	●	●	o	o	o	o
o	o	o	o	o	o	o	o	o	o	●	o	●*	o	o	o
o	o	o	o	o	o	o	o	o	o	●	o	o	●	o	o
o	o	o	o	o	o	o	o	o	o	●	o	o	o	●	o
o	o	o	o	o	o	o	o	o	o	●*	o	o	o	o	●
o	o	o	o	o	o	o	o	o	o	●	o	o	o	o	o
o	o	o	o	o	o	o	o	o	o	●	o	o	o	o	o
o	o	o	o	o	o	o	o	o	o	●	o	o	o	o	o

o Indicates nondisplay holes.

● Indicates display holes.

●* Indicates white "landmark" pegs.

DISPLAY NUMBER THREE

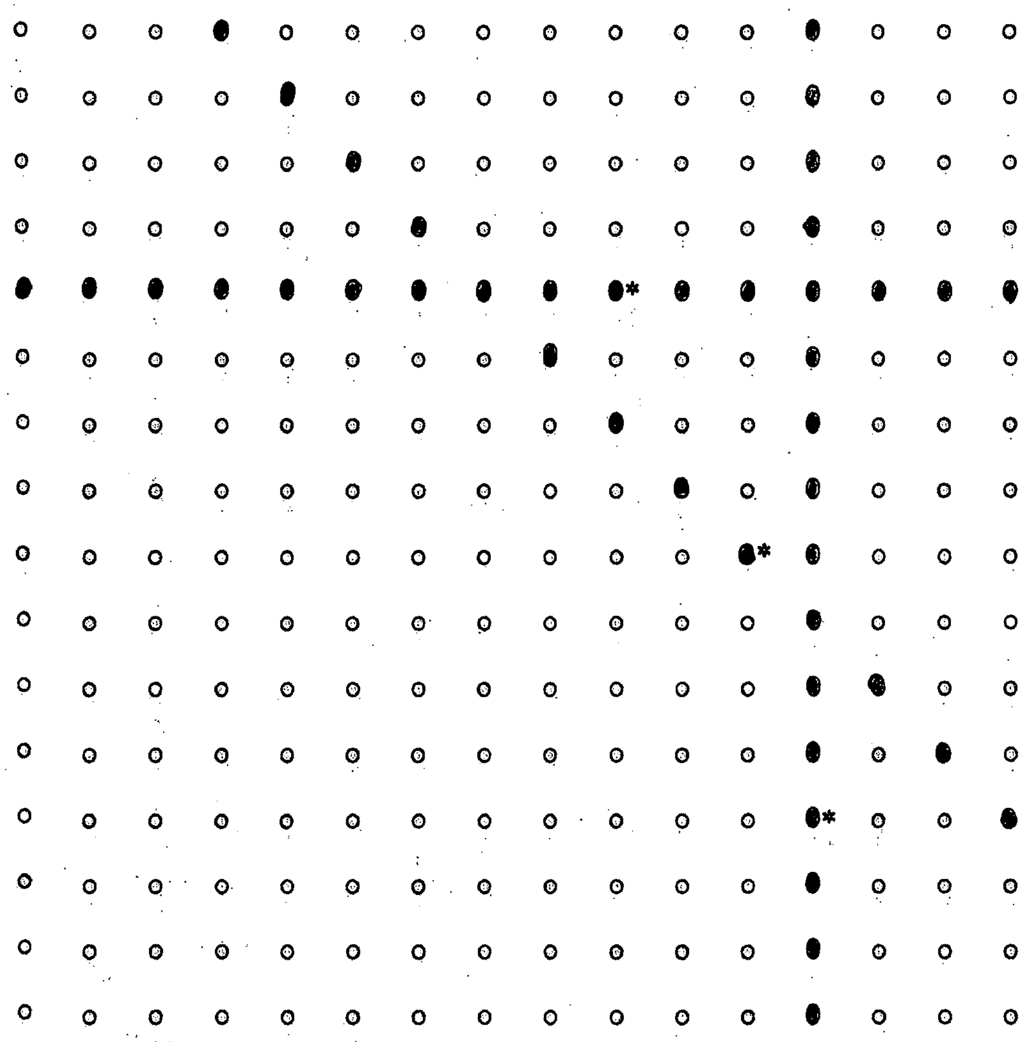


o Indicates nondisplay holes.

● Indicates display holes.

●* Indicates white "landmark" pegs.

DISPLAY NUMBER FOUR

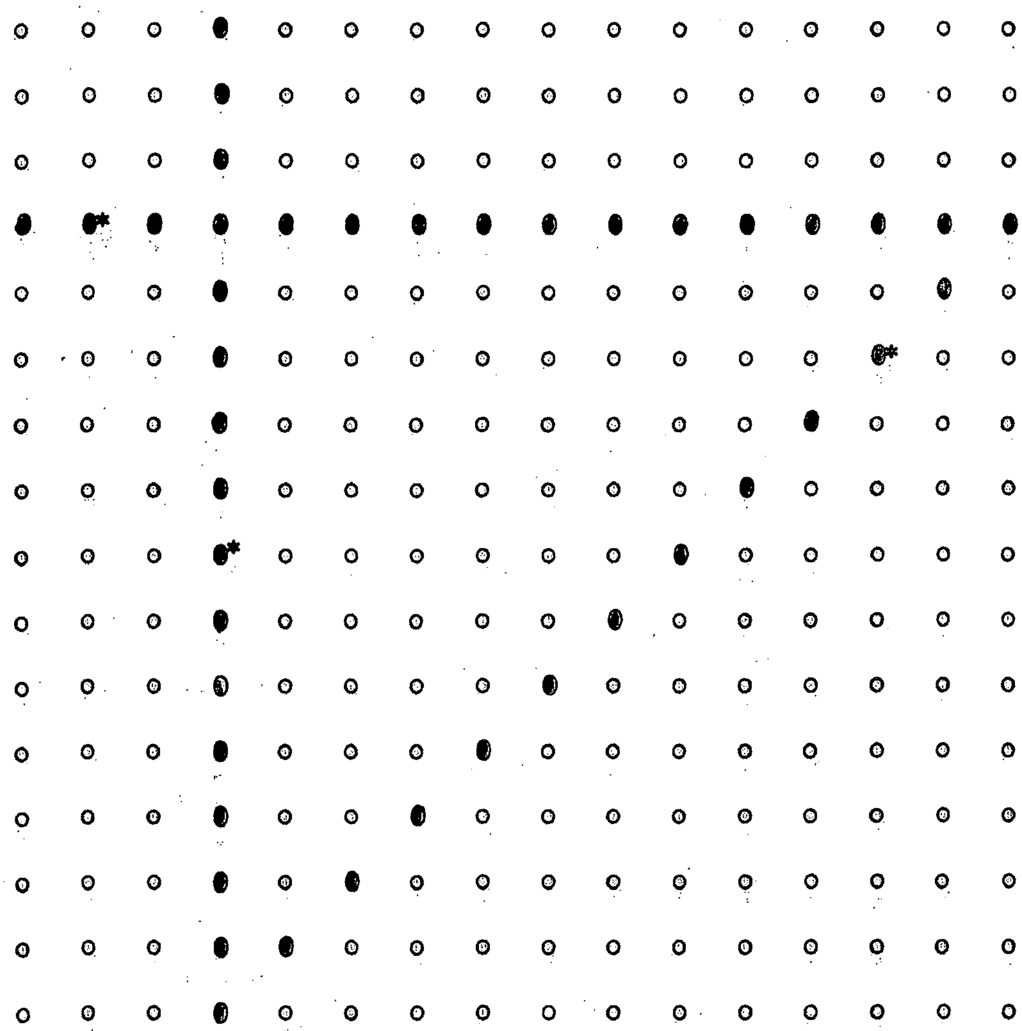


o Indicates nondisplay holes.

● Indicates display holes.

●* Indicates white "landmark" pegs.

DISPLAY NUMBER FIVE



o Indicates nondisplay holes.

● Indicates display holes.

●* Indicates white "landmark" pegs.

APPENDIX B

SUBJECT DATA SHEET

DATA SHEET

Name____Telephone______________________________

Address____

Date of Birth_____________________________Age______________________________________

Place of Birth____

Do you have any problems with Speech? If so, describe. _______________

____

____

____

Year and Major in College ____ ____

Comments ____

____

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APPENDIX C

RECEIVER ERROR SCORES AND DISPLAY NUMBERS

TABLE VIII

RECEIVER ERROR SCORES AND DISPLAY NUMBERS

Group Rn	Error Score	Display Number	Group Rs	Error Score	Display Number
Rn-1	95	2	Rs-1	0	3
Rn-2	0	2	Rs-2	0	1
Rn-3	213	3	Rs-3	25	2
Rn-4	211	4	Rs-4	0	2
Rn-5	200	4	Rs-5	0	5
Rn-6	208	2	Rs-6	180	2
Rn-7	139	5	Rs-7	0	5
Rn-8	207	4	Rs-8	1	1
Rn-9	123	1	Rs-9	0	4
Rn-10	113	2	Rs-10	3	1
Rn-11	0	4	Rs-11	183	2
Rn-12	15	5	Rs-12	0	3
Rn-13	181	3	Rs-13	0	2
Rn-14	0	3	Rs-14	201	4
Rn-15	35	1	Rs-15	197	3
Rn-16	121	1	Rs-16	170	5
Rn-17	206	5	Rs-17	156	3
Rn-18	0	2	Rs-18	184	4
Rn-19	152	3	Rs-19	202	5

TABLE VIII (cont.)

Group Rn	Error Score	Display Number	Group Rs	Error Score	Display Number
Rn-20	0	3	Rs-20	32	1
Rn-21	0	5	Rs-21	186	4
Rn-22	96	4	Rs-22	0	4
Rn-23	211	5	Rs-23	156	3
Rn-24	122	1	Rs-24	0	1
Rn-25	0	1	Rs-25	66	5
Median =	121		Median =	25	

APPENDIX D

ENCODER ERROR SCORES AND DISPLAY NUMBERS

TABLE IX

ENS ERROR SCORES AND DISPLAY NUMBERS

Subject	Display Number	Error Score Trial 1	Error Score Trial 2	Error Score Trial 3	Error Score Trial 4
ENS-1	2	92	0		
ENS-2	2	12	0		
ENS-3	3	57	1	0	
ENS-4	4	38	0		
ENS-5	4	52	36	0	
ENS-6	2	34	1	0	
ENS-7	5	32	0		
ENS-8	4	13	0		
ENS-9	1	35	2	1	0
ENS-10	2	18	1	0	
ENS-11	4	21	0		
ENS-12	5	55	0		
ENS-13	3	31	1	0	
ENS-14	3	18	1	0	
ENS-15	1	42	14	0	
ENS-16	1	116	1	0	
ENS-17	5	81	1	0	
ENS-18	2	36	0		
ENS-19	3	90	0		
ENS-20	3	32	0		

TABLE IX (cont.)

Subject	Display Number	Error Score Trial 1	Error Score Trial 2	Error Score Trial 3	Error Score Trial 4
ENS-21	5	21	0		
ENS-22	4	22	0		
ENS-23	5	55	1	0	
ENS-24	1	73	0		
ENS-25	1	30	0		
Median =		35			

TABLE X

ES ERROR SCORES AND DISPLAY NUMBERS

Subject	Display Number	Error Score Trial 1	Error Score Trial 2	Error Score Trial 3	Error Score Trial 4
ES-1	3	24	0		
ES-2	1	22	0		
ES-3	2	11			
ES-4	2	18		0	
ES-5	5	81	0		
ES-6	2	51	0		
ES-7	5	34	0		
ES-8	1	16	0		
ES-9	4	28	0		
ES-10	1	27	3	2	0
ES-11	2	17	1	0	
ES-12	3	22	0		
ES-13	2	51	1	0	
ES-14	4	102	0		
ES-15	3	15	0		
ES-16	5	95	0		
ES-17	3	83	0		
ES-18	4	37	0		
ES-19	5	51	0		
ES-20	1	18	0		

TABLE X (cont.)

Subject	Display Number	Error Score Trial 1	Error Score Trial 2	Error Score Trial 3	Error Score Trial 4
ES-21	4	6	0		
ES-22	4	32	0		
ES-23	3	59	3	1	0
ES-24	1	33	0		
ES-25	5	53	0		
Median =		32			

APPENDIX E

RECEIVER TIMES

TABLE XI

RECEIVER TIMES IN MINUTES

Group Rn	Time	Group Rs	Time
Rn-1	2.10	Rs-1	1.83
Rn-2	20.43	Rs-2	1.75
Rn-3	29.23	Rs-3	1.78
Rn-4	6.23	Rs-4	3.23
Rn-5	14.30	Rs-5	1.87
Rn-6	46.68	Rs-6	2.25
Rn-7	14.28	Rs-7	23.92
Rn-8	11.38	Rs-8	2.93
Rn-9	14.07	Rs-9	3.25
Rn-10	21.83	Rs-10	14.47
Rn-11	32.72	Rs-11	6.02
Rn-12	11.88	Rs-12	1.87
Rn-13	4.50	Rs-13	27.42
Rn-14	13.33	Rs-14	38.20
Rn-15	16.78	Rs-15	45.13
Rn-16	4.23	Rs-16	2.67
Rn-17	16.00	Rs-17	38.97
Rn-18	3.10	Rs-18	24.20
Rn-19	1.72	Rs-19	22.32
Rn-20	13.87	Rs-20	58.53

TABLE XI (cont.)

Group Rn	Time	Group Rs	Time
Rn-21	2.98	Rs-21	4.48
Rn-22	33.00	Rs-22	30.17
Rn-23	19.98	Rs-23	13.67
Rn-24	3.87	Rs-24	3.23
Rn-25	35.33	Rs-25	2.10
X =	393.82		376.26
$\bar{X}$ =	15.75		15.05

APPENDIX F

ENCODER TRIAL TIMES

TABLE XII

ENS TRIAL TIMES IN MINUTES

Subject	Trial 1	Trial 2	Trial 3	Trial 4
ENS-1	13.65	1.75		
ENS-2	2.83	1.32		
ENS-3	8.08	1.42	1.33	
ENS-4	21.07	1.40		
ENS-5	9.17	14.75	2.25	
ENS-6	14.92	1.58	1.83	
ENS-7	12.10	1.52		
ENS-8	4.12	1.03		
ENS-9	4.02	1.67	2.33	1.47
ENS-10	3.83	1.87	2.03	
ENS-11	12.37	2.37		
ENS-12	15.35	1.10		
ENS-13	5.95	1.57	1.42	
ENS-14	3.85	1.40	1.87	
ENS-15	5.00	2.32	1.33	
ENS-16	7.65	1.52	1.48	
ENS-17	6.42	1.35	1.35	
ENS-18	20.17	1.17		
ENS-19	5.18	1.50		
ENS-20	5.52	1.62		

TABLE XII (cont.)

Subject	Trial 1	Trial 2	Trial 3	Trial 4
ENS-21	4.92	1.40		
ENS-22	4.75	1.40		
ENS-23	4.30	1.58	1.38	
ENS-24	25.80	1.58		
ENS-25	11.33	1.83		
X =	232.35	53.02	18.60	1.47
$\overline{X}$ =	9.29	2.12	1.64	1.47

TABLE XIII

ES TRIAL TIMES IN MINUTES

Subject	Trial 1	Trial 2	Trial 3	Trial 4
Es-1	5.42	1.67		
ES-2	3.25	1.23		
ES-3	3.22	1.62		
ES-4	3.27	2.75	3.15	
ES-5	5.47	1.28		
ES-6	22.97	3.75		
ES-7	3.70	1.25		
ES-8	11.82	2.03		
ES-9	8.45	1.88		
ES-10	4.42	2.00	1.87	1.60
ES-11	1.90	1.48	1.03	
ES-12	3.00	8.06		
ES-13	5.76	1.47	1.32	
ES-14	8.25	1.37		
ES-15	2.62	1.53		
ES-16	10.13	1.92		
ES-17	45.27	1.62		
ES-18	3.15	1.87		
ES-19	4.97	1.47		
ES-20	4.32	2.05		

TABLE XIII (cont.)

Subject	Trial 1	Trial 2	Trial 3	Trial 4
ES-21	2.83	1.78		
ES-22	8.72	5.57		
ES-23	12.20	3.33	1.83	1.45
ES-24	7.42	1.83		
ES-25	6.97	1.92		
X =	199.50	56.73	9.20	3.05
$\bar{X}$ =	7.98	2.27	1.84	1.53

APPENDIX G

ENCODER RECORDING TIMES

TABLE XIV

ENCODER RECORDING TIMES IN MINUTES

Group ENS	Time	Group ES	Time
ENS-1	0.80	ES-1	1.00
ENS-2	1.22	ES-2	1.70
ENS-3	1.50	ES-3	3.57
ENS-4	1.88	ES-4	0.92
ENS-5	0.92	ES-5	1.20
ENS-6	1.85	ES-6	1.75
ENS-7	0.83	ES-7	1.42
ENS-8	1.33	ES-8	0.62
ENS-9	1.43	ES-9	1.50
ENS-10	2.73	ES-10	0.75
ENS-11	3.17	ES-11	1.25
ENS-12	1.45	ES-12	2.77
ENS-13	1.07	ES-13	1.73
ENS-14	1.92	ES-14	1.62
ENS-15	1.22	ES-15	1.23
ENS-16	0.65	ES-16	1.73
ENS-17	0.95	ES-17	0.72
ENS-18	1.55	ES-18	0.85
ENS-19	2.27	ES-19	1.12
ENS-20	2.12	ES-20	1.17

TABLE XIV (cont.)

Group ENS	Time	Group ES	Time
ENS-21	0.63	ES-21	0.57
ENS-22	0.87	ES-22	3.28
ENS-23	1.53	ES-23	1.02
ENS-24	1.28	ES-24	1.85
ENS-25	4.08	ES-25	2.82
X =	39.25		38.16
$\bar{X}$ =	1.57		1.53

APPENDIX H

SELECTED TRANSCRIPTIONS OF RECORDED MESSAGES

MESSAGE OF ENS-12

The experiment is composed of a flat piece of wood with a series of holes in it. The object is to place a number of plungers in the right holes, making the fewest mistakes. There's a specific design. It is composed of two lines that cross each other, forming somewhat of a cross, and a third line connecting the right end of the cross with the bottom of it. Now the horizontal part of the cross is four holes from the top; it goes horizontally across the board--all the way across. It---The vertical part is three holes, I believe, from the left hand side of the board. The third line connects the very right hand portion of the horizontal line, the very farthest right extreme hole. A line connects that with the bottom extreme hole. You ah---the white plungers---the white plungers indicate where the lines roughly lie, as the lines all go through these white plungers.

MESSAGE OF ENS-23

The resulted task will be an upsidedown four of black---excuse me---of red and white pegs. The first thing to do is go horizontally clear across the board with red pegs, going through the top---the highmost white peg. After you have gone clear across the board with all the red pegs through the white peg, go diagonally from the far right of the board down in a diagonal direction so that you pass through the white peg on the far right. After you have gone diagonally through the white peg down clear to the bottom of the board with the red pegs, make a straight line upward---a ninety-degree angle from the bottom---passing through the middle white peg. You should proceed to the very top with the red pegs.

MESSAGE OF ENS-2

First of all there are three white pegs; this is the secret to figuring out the puzzle. The first peg is on the third line from the top. If you go from right to left in the same direction in the same row as the white peg---it's the third one from the top---you will complete the first bar of the puzzle. Then the second white peg is approximately six holes to the left of the puzzle. If you go from top to bottom, in the order of this white peg, you will fill the second line. The third peg will complete the last line of the puzzle. It's a diagonal line that crosses both the horizontal and vertical line.

MESSAGE OF ES-5

Starting at the lower left-hand corner of the problem, count three vertical rows to your right and begin placing pegs from the bottom to the top along the fourth vertical row---that's the fourth row from your left---filling in the complete row from top to bottom. Then counting three rows down from the top left---three horizontal rows down from the top left---begin placing pegs in the fourth horizontal row, completely filling the row from left to right. Then, on the right-hand corner of the problem, four vertical rows down, bisect---commence placing pegs in a diagonal manner bisecting from the last peg in the fourth horizontal row---that's the fourth horizontal row on the right---to the beginning peg on the fourth vertical row on the lower left, thus forming a triangle which bisects itself on the upper left hand corner.

MESSAGE OF ES-16

In proceeding to---ah---fill out the pattern, start with the upper left-hand white peg and work in a straight line horizontally across the board, filling in all the peg holes to the right of the white peg. After this is completed you will find the peg hole to the left of the white peg. Fill this in too. The next step is to proceed vertically from the white peg to the bottom of the peg board. This will be in a line from the white peg. And then also go from the white peg vertically upwards to the top of the board. At this time you should have a pattern resembling an upsidedown four. If---oh, wait a minute. Ah---the next step is to take your top horizontal line and your vertical line and work from the corners of each in a straight line, so that you---you will go directly from the corner of your horizontal line to your vertically line downward. And when you get---when you have completed you will have an basically upsidedown four.